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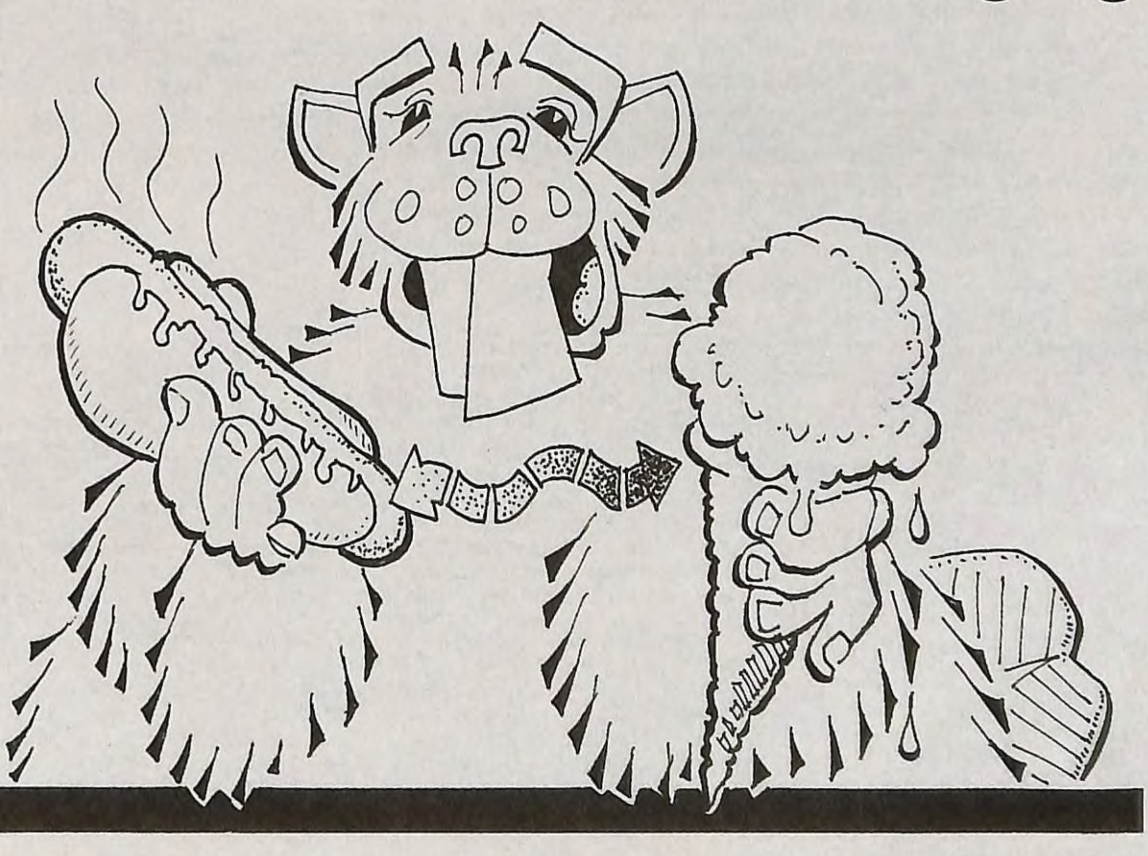
Inside . . .

Thermal Bridging



From The Editor . . .

We Canadians pride ourselves on building the best housing in the world. We believe that we are at the forefront of residential construction practices and technology. But is that really the case?

Maybe my age is showing and I'll come across as a crotchety old man, but as I observe the interest in ever higher performance housing, it seems to me that we have lost the enthusiasm and passion of a generation ago to back-up and ensure that innovations will be sound and durable.

There was a time that Canada was doing ground-breaking construction research. The documents that were published by the National Research Council and CMHC became textbooks for the industry. Builders and designers in other countries looked enviously at what was happening in Canada and followed in our footsteps.

Although educational opportunities have increased through new construction and building science programs at community colleges and universities, the support for research and innovation that supports the training and education has been snuffed out.

The limited amount of support available is tied to corporate contributions, which tends to keep public access to research findings under wraps as much is kept behind the curtain of corporate competitive interest. Findings that product A may be worse than B or that C is inappropriate are kept under wraps especially if A or C were even slightly involved with the investigation. Limited resources are made available to maintain, let alone advance, construction technology – this at a time that we need to do more, and not less.

We need to be mindful of changes in technology, materials science, and public expectations. Each has a place, but must be evaluated and adapted to specific climates and applications. Unlike consumer electronics, time and place does make a difference.

We Canadians were pioneers in energy efficient home construction only a generation ago. It wasn't just a matter of putting more insulation into walls and attics, but actually looking at the whole building. Perhaps more important than just generating higher performance specifications, was the focus on the 'house-as-a-system'. This concept recognizes that any building or house is more than just an assembly of products – it is a whole system where the major components and sub-systems are interdependent. These include the building envelope itself, the mechanical systems, and the occupants. Each of these can have an impact on the performance of the whole building.

We need to keep this idea in mind as the drive for sustainable zero energy housing is gaining traction. We are seeing a resurgent interest to improve housing technology, to achieve homes that are not only more energy efficient but that are also healthier as well as more comfortable.

This is going to require the capacity to deal with new issues that will pop up when dealing with new technologies and the consequences, intended or unintended, of the new directions. Where once we were pioneers, we seem to have fallen behind and are now followers, importing ideas and products from foreign sources. Although ideas and concepts have no boundaries, specific products and applications are site and climate specific. An over reliance on imports does a disservice to our industry, economy and even self-confidence. It is time for us to recapture the spirit and excitement of innovation.

Richard Kadulski
Editor

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Thermal Bridging

Thermal bridging can be seen in the infrared photo of this older house.

Thermal bridging is the new buzzword that is changing how we look at detailing of construction assemblies. Standard construction practices need to be modified in order to attain higher performance, especially to address thermal bridging across the framing. In order to address this issue, the latest version of the National Building Code now requires that effective R-values be used when determining code compliance.

At first it may seem like a startling change to how we do business, although innovative designers and builders have been finding ways to build with more energy efficient construction details. Once you've worked out the kinks in any new assembly you work with to deal with thermal bridging, it will become the new normal. You may wonder why we've not dealt with this issue before, and what the fuss was all about.

Higher performance requirements, along with a deliberate move towards the use of effective insulation calculations, rather than nominal insulation values to reduce thermal bridging, will mean that changes to current construction practices will become mainstream.

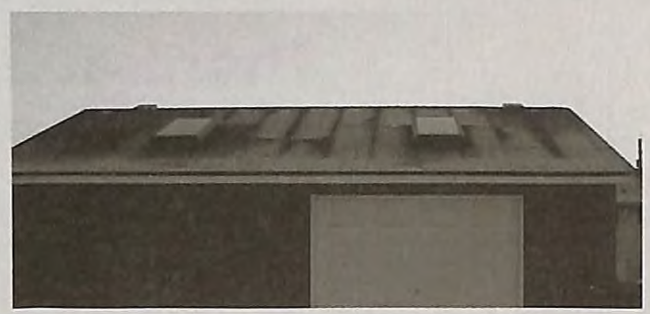
What's Thermal Bridging?

Thermal bridging happens when a conductive material provides a path for heat to flow around insulation. The bypassing (or "bridging") of the less conductive insulation material significantly reduces the effectiveness of the insulation and thus the overall performance of the whole assembly. Examples of higher conduction materials include wood framing (studs, plates, cripples) in an insulated wall, cantilevered framing, steel framing, masonry ties and other cladding attachments that penetrate through exterior insulation, and shelf angles that support masonry. In concrete construction, it can be the concrete slab edge through the wall (of a cantilevered balcony or an exposed slab edge).

Up to now, we've dealt with the energy performance requirements by using nominal R-values. Nominal R-values are the rated R-value of the insulation alone. Using nominal values does not take into account how the insulation is installed. For example, placing R-20 batt insulation into a typical 2x6 wood frame wall provides a wall with an approximate effective R-15, while placing the same R-20 batt in a 2x6 steel frame nets an effective R-9. Masonry ties and shelf-angles, even thought they represent a small area, are thermal bridges that further reduce the effective R-values.

Wood-frame construction is inherently more thermally efficient due to the lower conductivity of wood compared to concrete, steel-frame, and masonry construction. As a result, the impact of thermal bridges caused by wood framing is less than in materials typically used in non-combustible construction. The low conductivity of wood also makes it easier to account for thermal bridging in calculations because lateral heat flow is less of an issue and assumptions of parallel path heat flow are more valid for most wood-frame details. Since it is more easily determined, energy standards account for more thermal bridging in wood-frame construction than for other types of construction.

Conventional wood frame construction results in quite a low effective performance, because of the thermal bridge through the wood framing. The R-value of framing lumber, depending on species, is about 1 – 1.25/inch thickness. Thus a 2x6 wood stud has an R-value of about 6.4, while the adjoining cavity can be insulated for its full depth, and depending on type of insulation used, can have R-20 to R-24 (if fiberglass batts) and up to about R-30 (if medium density spray foam insulation is used). But because the framing can account for about 23% of the wall surface area (that's the code default value for conventional construction), the effective thermal insulation of the overall wall, when the surface areas are averaged, will be much less.



Impact Beyond Heat

Heat flows from warm to cold, following the path of least resistance so the impact of a thermal bridge can be very significant. Any path that is a better conductor of heat will see more heat flow compared to areas that have less. This is not just a matter of greater heat loss and a less efficient building. It can lead to condensation, mould growth and premature deterioration of building materials.

Until recently, most code requirements for insulation were done simply by reference to the nominal insulation levels in the assembly, rather than the effective R-value. This is now changing, and new energy codes are requiring the use of effective R-values. The calculations done with HOT-2000 for Energuide labelling and for various energy efficiency programs have already been using the effective R-values.

That is why new code requirements for improved energy efficient construction, as well as the renewed interest in high performance programs such as R-2000, Energy Star, Built-Green, and Novoclimat will see an increased use of continuous insulation across the the envelope of the building.

More importantly, the net impact of thermal bridging is lower interior surface temperatures. During cold conditions this can mean condensation and mould growth, so that besides achieving a more energy efficient building, it's also something that will provide a more durable building.

In poorly insulated and older buildings the visible ghosting on wall surfaces is an indication of thermal bridging. It's highly visible with an infrared camera. It can also be seen on a cold day, especially in winter, if you look at the roof. After a snowfall, or even after a cold, clear night, you can see the thermal bridging through the framing.

> Masonry ties occupy only 0.04% of a typical wall surface area, however, depending on the type of tie, they can reduce the effective value of exterior insulation between 5-30% for typical insulation depths, and should be accounted for in energy calculations, especially in highly conductive structures such as steel or concrete. Similarly, masonry shelf angles can reduce effective values of insulation up to 45-55% unless they are thermally broken.
>
> The effect would be slightly less in wood frame structures.

More Accurate Heat Loss Calculations

Heat loss calculations, even when taking thermal bridging into account, are based on the assumption that the heat flow follows parallel paths. That means the heat flows through the studs and through the insulation, and the overall average is determined by calculating areas of each and determining an average based on areas of each. However, heat flow is not parallel, but three-dimensional, including at interfaces between different materials, which means it also flows along the materials. In the case of wood framing, the three-dimensional flow heat is not as significant as it is in the case of concrete and steel construction.

Taking these three-dimensional heat flows into account when doing calculations can be cumbersome, and is not normally done. The assumption has been that because the overall area of these bridging elements is so small, the errors introduced by neglecting them was not that significant..

Challenge For Builders

The challenge for builders is how to structurally attach exterior claddings over continuous exterior rigid insulation while avoiding thermal bridging. This becomes a greater challenge as thicker insulation levels are used to achieve higher performance levels or to meet more stringent effective R-value requirements.

In addition, there is the concern about how to detail windows, doors and other penetrations in walls with continuous insulation.

Some siding manufacturer's installation instructions limit the thickness of continuous insulation to one inch. It is assumed that this current limitation is based on lack of knowledge of the loading on the fastener that would be incurred with greater thicknesses.

Foam insulation manufacturers in the US have created the Foam Sheathing Coalition to focus on common issues such as addressing solutions to building code issues and promoting the proper technical use of foam sheathing. They have funded research related to the use of foam sheathing, not only insulation and moisture issues, but also the structural concerns related to the use of insulating sheathing products. Analysis has been done by tests as well as engineering calculations, with special focus on the fasteners that are expected to carry the exterior siding loads.

A major concern with the use of continuous exterior insulation is that the exterior cladding is moved out from the structure so the fasteners carrying the cladding may in effect be cantilevered from the structure, and may be required to carry a greater load.

Fastener choice is dependent on the weight of the cladding material to be attached to the building. The weights of common siding materials are shown in the table.

It was found during testing that the connection strength was higher for greater foam insulation thicknesses when compared to the same fastener without any foam. Important factors that affect the performance are the washer on the fastener that distributes and transfers loads, and how tightly the fastener is installed so that there is good compression of the foam board. Generally, nails are acceptable if some type of wood-based surface is used over or under the exterior insulation. Oriented strand board (OSB) sheathing and wood furring strips should be investigated.

Screws are generally the preferred method for attaching cladding or furring strips to steel-framed walls. Codes have historically left much of the prescriptive requirements for siding attachment to manufacturers' installation recommendations. Only recently have codes begun to question whether all applicable loads were being addressed.

Further, the recommendations of manufacturers and code requirements have developed over the years based mostly on experience. These recommendations were never intended to apply to the more recently developed assemblies with thick layers of exterior continuous insulation.

The load bearing capacity of any screw or nail depends on the diameter, length, thread type, material strength, and metal gauge, and it increases with foam thickness – indicating that the assembly works as a system.

Recent work indicates that No. 8 screws spaced about 12" on centre can be used for insulation thicknesses of up to about 3 inches thick. The screws hold ¾" strapping in place. The strapping then carries the exterior cladding.

The strapping that carries the cladding defines a rain screen at the same time. Although the code may require a rain screen only in certain locations defined by the climatic conditions, any building scientist will tell you that a rain screen assembly makes sense in all climatic zones – and will create a durable building. Moisture damage has been observed in buildings located even in quite dry climates.

City of Vancouver Experience

The City of Vancouver introduced a requirement for wall insulation to achieve an *effective* R-22 value. This has created much angst in the industry. Although deeper framing, such as 2x8 studs, fully insulated, will achieve the R-22 effective, continuous insulation across the exterior is the better way to achieve a higher performance wall.

Since the requirements came into effect January 1, 2015, with a backlog of permit applications made at the end of December to fall under the old requirements it is still too early to fully appreciate the impact of the new requirements or what types of assemblies builders will be using.

The industry is still in a learning curve stage – there has been some pushback when new detailing approaches are suggested. It's similar to the angst that happened when rain screen detailing was mandated on the West Coast. Outrageous incremental costs were quoted for detailing rain-screen, and although there are incremental costs associated with rain screen detailing, it quickly became the norm. New ways to detail were found, and a range of new products appeared on the market to make it easier and more economical to achieve functioning rain-screen assemblies.

The most effective and thinnest wall (important in a city with high costs and where zoning restrictions are tight, with floor area calculations carefully calculated to the outside face of the house) is a 2x4 frame wall with R-14 batt insulation and 2" of extruded polystyrene on the exterior. But we've heard comments about this wall assembly, questioning the structural adequacy of 2x4 framing and market acceptance of a 2x4 framed wall.

Siding Material Weights

Siding Material	Typical Weight of Siding Material (psf)
Vinyl Siding	1.4-1.6
Fiber Cement	2.3
Wood Lap	2.5-3.1
Direct Adhered Brick and Stone Veneer	9.0-15.0
Anchored Brick and Stone Veneer	47.0
Stucco	10.4

Minimum Siding Fastening Required for Direct Attachment of Foam Sheathing on Wood Framing (minimum 1 ¼" penetration to wood)

Siding Fastener Type	Siding Fastener Vertical Spacing	Maximum Thickness of Foam Insulation					
		16" o/c stud spacing			24" o/c stud spacing		
		Max cladding weight			Max cladding weight		
		3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
0.113" diameter nail	6	4	3	1	4	2	.75
	8	4	2	.75	4	1.5	DR
	12	4	1.5	DR	3	.75	DR
0.120" diameter nail	6	4	3	1.5	4	2	.75
	8	4	2	1	4	1.5	.5
	12	4	1.5	.5	3	1	DR
0.131" diameter nail	6	4	4	1.5	4	3	1
	8	4	3	1	4	2	.75
	12	4	2	.75	4	1	DR
DR = Design required							
For cladding system weights more than 25 psf with any thickness of foam sheathing, a design professional needs to be consulted.							

Minimum Fastening Required for Rain Screen Furring Over Foam Sheathing on Wood Framing (1 x 3 wood Furring)

Fastener Type	Min. penetration into wall framing	Fastener Spacing in Furring	Maximum Thickness of Foam Insulation					
			16" o/c stud spacing			24" o/c stud spacing		
			Max cladding weight			Max cladding weight		
			3 psf	11 psf	25 psf	3 psf	11 psf	25 psf
Nail: 0.120" shank; 0.271" head	1 ¼"	8	4	4	1.5	4	2	1
		12	4	2	1	4	1.5	0.5
		16	4	2	0.5	4	1	DR
Nail: 0.131" shank; 0.281" diameter nail	1 ¼"	8	4	4	2	4	3	1
		12	4	3	1	4	2	.75
		16	4	2	.75	4	1.5	DR
#8 screw	1"	12	4	4	1.5	4	3	1
		16	4	3	1	4	2	.5
		24	4	2	.5	4	1	DR
DR = design required								
For cladding system weights more than 25 psf with any thickness of foam sheathing, a design professional needs to be consulted.								

Concerned about how to attach the rain screen furring? One application we've noted the contractor used a single nail to position and hold the furring in place, then went back with screwdriver to screw the furring – using a #8 screw at 12" centres.

Effective Insulation Calculations: the Little Stuff

Code requirements for effective R-value calculations require taking into account all repetitive structural elements, such as studs, joists, lintels, sills and plates.

Minor penetrations, such as pipes and ducts, shelf angles, anchors, fasteners and nails don't have to be considered – they usually do not amount to much of the surface area so their impact is quite modest – and difficult to calculate practically, consequently the code ignores them.

Major structural penetrations, such as balcony slabs, beams, columns and ornamentation can also be excluded from calculations provided that the insulation is brought tight to the penetrating element, and that their total area does not exceed 2% of the surface area of the wall. Except for an unusual house design, this will not be a factor in houses.

Some thermal bridges can be completely avoided or substantially decreased, such as concrete shear walls or eyebrows.

However, the impact of penetrations can be significant, especially in larger buildings, and buildings that are primarily concrete, steel-frame and masonry construction. For example, in high-rise multi-unit residential buildings (typical concrete construction), the Morrison Hershfield study calculated that the cantilevered balconies are approximately 2.7% of the total opaque wall area. However, this area can account for about 15% to 30% of the heat flow through the walls. The relative impact depends on the efficiency of the wall assembly and other interface details.

As new knowledge is gained about the impact of even minor thermal bridges, and new tools are developed, even the minor penetrations will start to be considered in energy calculations. These tools will not require counting every last fastener or piece of strapping that creates a thermal break, but will likely incorporate factors based on the type of assembly and type of thermal bridge.

Building Envelope Thermal Bridging Guide

Morrison Hershfield in a project for ASHRAE studied the issue and put forward procedures and generated data to allow practitioners to evaluate the impact of thermal bridging in a comprehensive and straightforward method. They prepared a catalogue of 40 common building envelope assemblies for mid- and high-rise construction. This was a start in creating a building envelope thermal performance catalogue that has been expanded now in a new ***Building Envelope Thermal Bridging Guide***. The development of the guide was funded by BC Hydro, the Canadian Wood Council, Fortis BC, FPInnovations and the Homeowner Protection Office. (It can be viewed and downloaded from the HPO website *hpo.bc.ca* – look under publications).

The thermal bridging guide explores how the building industry can meet the challenges of reducing energy use in buildings in part by effectively accounting for the impact of thermal bridging. It provides an enhanced catalogue of thermal performance of common envelope assemblies and interface details, outlines information needed for thermal bridging design and whole-building energy simulations, and evaluates cost effectiveness of improving the building envelope through different methods, building types and climates

Interface Details

Design decisions made by architects and designers can have a big impact on the overall building performance. Interface details between different materials and design elements, typically will lead to additional heat flow. Examples include articulated architecture (dormers, bays, stepped walls, etc) and many small windows separated by small areas of opaque walls.

Good practice for heat loss design analysis requires a careful review of the building envelope based on the architectural drawings. Good design requires that a heat loss calculation be done room-room, to minimize over or under sizing of equipment.

However, design procedures do not take into account the impact of the interface details, such as the detail between a window and wall assembly. Some assemblies inherently have less thermal bridging at interface details.

The Building Envelope Thermal Bridging Guide analysis notes that adding more insulation to an already well-insulated wall assembly, with common interface details, can have little impact on building energy use. This is true for both wood-frame and non-combustible construction. So that just adding more insulation to a wall assembly will have diminishing returns regardless of the interface details. But if there are significant thermal bridges because of the nature of the detailing, these diminishing returns are greater because of the thermal bridges.

The moral of the story: pay attention to the details – reduce thermal bridging to achieve a net improvement.

Types of Continuous Insulation

Expanded polystyrene (EPS) - rigid foam plastic insulation manufactured from expandable polystyrene resin containing a blowing agent that is exposed to steam and subsequently molded into the desired shape resulting in a closed cell structure. It can also be used below grade.

Extruded polystyrene (XPS) - rigid foam plastic insulation manufactured by extrusion and expansion of polystyrene monomer, the base polymer, in the presence of a blowing agent resulting in a closed cell structure. This is a low permeance material that could be considered a vapour barrier. It can also be used below grade.

Polyisocyanurate or polyiso (PIR) - a closed cell, rigid thermosetting plastic foam board manufactured from a mixture of certain types of polyols and isocyanate (polymeric methyl diphenyl isocyanate or MDI) with a blowing agent that is reacted into a rigid board, but it can shrink (up to 2%). It cannot be used below grade. It has a slightly higher R-value (R-5.7/inch) than XPS.

PIR products have a high initial R-value, which is often referenced in sales literature, especially in the USA, but because the blowing agents that give it the high R-value dissipate over time. The accepted Canadian Long Term Thermal R-value (LTTR) is 5.7/inch.

Rigid mineral wool – mineral wool formatted into a compact non-structural insulation board. It is non-combustible, water repellent and fire resistant that can be used as an exterior non-structural insulation sheathing that provides a continuous layer of insulation above grade. It can also be used below grade as a foundation insulation and drainage board.

Medium Density (2-lb) spray foam insulation. This is sometimes used in commercial construction projects, in part as an attempt to deal with thermal bridging issues. It is rarely used for exterior insulation of houses, as it requires appropriate conditions for application, detailing concerns, and cost. The low-permeance properties of the material itself qualifies the 2-lb foam as a vapour barrier also, so careful consideration is required if using split insulation (continuous insulation across the exterior, plus insulation on the interior) to ensure there is an acceptable outboard/inboard ratio for the climate zone in which the house is located.

Continuous Sheathing Insulation

All continuous sheathing insulation products perform the same function – to improve the energy efficiency and moisture resistance of the typical framed wall with cavity insulation – along with the control of the following:

- Heat flow
- Airflow
- Rain penetration
- Water vapor flow
- Condensation

However, rigid foam board sheathing products are NOT structural sheathings. They all require some type of structural bracing solution to meet building code wall bracing requirements.

Continuous Sheathing Applications

* Provide an effective means of meeting energy code requirements and preventing thermal bridging across the building envelope

* Easily adaptable to exceeding minimum code energy efficiency requirements required for voluntary programs such as Energy Star, Built-Green, R-2000 or Passive House.

* Can be detailed to provide a code-compliant water-resistive layer behind siding to simplify wall construction and prevent rainwater penetration.

* Can be specified to provide control water vapor flow and condensation potential in wall assemblies

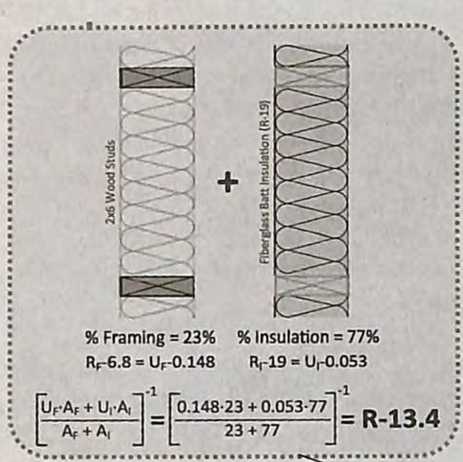
* Adaptable to use with a variety of code-compliant structural wall bracing methods:

R-22+ Effective Wood Frame Walls

The City of Vancouver, uniquely in Canada, has the authority to write its own building code. They generally are in sync with the BC Building Code, which in turn generally adopts the latest National Building Code with minor tweaks.

However, the latest changes made by the city have set them apart from the remainder of BC when it comes to energy efficiency regulations. The new energy regulations are driven by the city's policy known as the Greenest City Action Plan – a strategy for staying on the leading edge of urban sustainability. The stated objectives are to require all buildings constructed from 2020 onward to be carbon neutral in operations, and to reduce energy use and greenhouse gas emissions in existing buildings by 20% over 2007 levels.

The new regulations that came into force January 1, 2015 require all one and two family dwellings to match a much higher standard than required in the National Building Code (Section 9.36). Vancouver is located in climate zone 4 (less than 3000 degree days °C), but the prescriptive criteria are close to those required in zones 6 or 7.



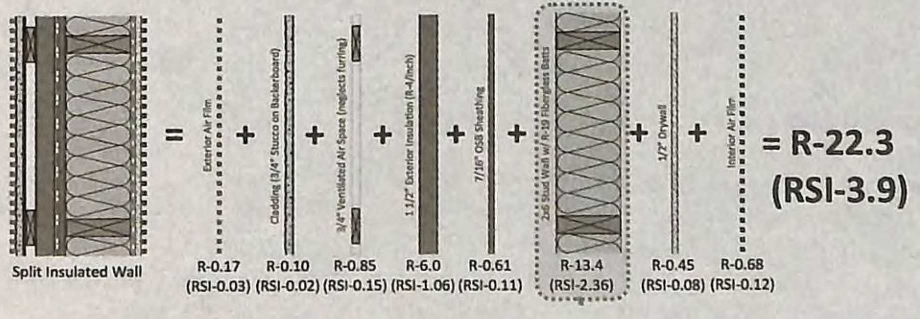
ILLUSTRATED GUIDE

Aside from a requirement that all houses must meet an airtightness test of at least 3.5 air changes at 50 Pascals (compared to current average construction practice of around 5 air changes for new houses), the most significant item is the requirement for exterior walls to have an effective R-22 (RSI 3.85). The equivalent minimum effective wall R-value required by the BC Building Code in zone 4 for walls is R-15.78 (RSI 2.78).

Recognizing the challenges that would be faced by the industry, the city partnered with the Homeowner Protection Office to develop a guide to R-22 effective or greater wall assemblies. The information included in this document is relevant for low-rise wood-frame residential buildings across British Columbia, which has all climate zones south of 60° found in Canada, so it will be relevant in most parts of Canada.

The guide is a valuable reference tool that is intended to be an industry, utility, and government resource with respect to meeting the aggressive performance levels required by the city, while not compromising other aspects of building enclosure performance, including moisture management, air leakage, and durability. It includes illustrations and key considerations for building four different types of above-grade and two types of below-grade walls assemblies.

In many cases the guide provides best practices with respect to air, vapour, and moisture management, rather than minimum requirements as specified by relevant building regulations. This approach was done deliberately, intended to



The R22+ Effective Walls guide was funded by the City of Vancouver and the Homeowner Protection Office (HPO), a branch of BC Housing, and was prepared by RDH Building Engineering Ltd. It is available on-line at the HPO website: www.hpo.bc.ca and look for publications.

Effective Assembly R-value for Deep Stud Walls [ft² • °F • hr/Btu]						
	Uninsulated Wood-Frame Service Wall			Insulated (R-12) 2x4 Service Wall		
	R-value/inch of Insulation			R-value/inch of Insulation		
Framing Type	R-3.4	R-4.0	R-5.0	R-3.4	R-4.0	R-5.0
2x6	17.7	18.9	20.5	25.2	26.3	28.0
2x8	21.9	23.5	25.6	29.4	31.0	33.1
2x10	26.7	28.7	31.5	34.2	36.2	39.0
2x12	31.6	34.0	37.3	39.0	41.5	44.8
8" EWI*	24.0	26.2	29.6	31.4	33.7	37.1
10" EWI	29.9	32.9	37.5	37.3	40.4	45.0
12" EWI	35.8	39.6	45.4	43.2	47.1	52.8
14" EWI	41.7	46.3	53.3	49.1	53.8	60.7
16" EWI	47.6	53.0	61.1	55.0	60.5	68.6

A 23% framing factor is assumed which is consistent with standard 16" o.c. stud framing practices. Reduced framing factors may be possible. *EWI = Engineered Wood I-Joist

Effective Assembly R-value of Split Insulated Wall Assembly [ft² • °F • hr/Btu]				
	2x4 Stud Wall (R-12 Batts)		2x6 Stud Wall (R-19 Batts)	
	R-value/inch of Exterior Insulation			
Thickness of Exterior Insulation	R-4.0	R-5.0	R-4.0	R-5.0
0"	11.3	11.3	16.2	16.2
1/2"	13.3	13.8	18.2	18.7
1"	15.3	16.3	20.2	21.2
1 1/2"	17.3	18.8	22.2	23.7
2"	19.3	21.3	24.2	26.2
2 1/2"	21.3	23.8	26.2	28.7
3"	23.3	26.3	28.2	31.2
3 1/2"	25.3	28.8	30.2	33.7
4"	27.3	31.3	32.2	36.2
4 1/2"	29.3	33.8	34.2	38.7
5"	31.3	36.3	36.2	41.2
5 1/2"	33.3	38.8	38.2	43.7
6"	35.3	41.3	40.2	46.2

A 23% framing factor is assumed which is consistent with standard 16" o.c. stud framing practices.

Samples of some of the tables of effective insulation values for walls with different insulation thicknesses. Valuable added information includes a discussion of the relative life-cycle environmental impact of each of the wall assemblies type, and an extensive list of additional resources and references.

promote the construction of effective and durable assemblies. In some cases the guide identifies materials, assemblies, or practices for which a registered professional (i.e. registered architect or engineer) may be required by the authority having jurisdiction to indicate equivalency for compliance with relevant building regulations.

An overview of alternative R-22 wall assemblies is also presented. Four different above-grade wall assemblies that can achieve the R-22 thermal performance target are discussed:

Split Insulated Walls. This above-grade wall assembly has rigid or semi-rigid insulation placed on the exterior of a conventional insulated 2x4 or 2x6 wood-frame wall. High effective R-values are achieved by using continuous insulation outside of the structural framing and thermally efficient cladding attachments, in combination with insulation in the stud space.

Exterior Insulated Walls. This wall assembly consists of rigid or semi-rigid insulation placed on the exterior of a conventional uninsulated 2x4 or 2x6, wood-frame wall assembly. High effective R-values of the assembly are achieved by using continuous insulation outside of the structural framing in combination with thermally efficient cladding attachments.

Double Stud Walls. This wall assembly consists of a deeper stud cavity created by an additional framed wall installed to the interior of a conventional wood-frame wall. High effective R-values are achieved by filling the increased cavity depth with either batt insulation, blown-in fibrous insulation, or spray foam insulation. There is no exterior insulation installed in this assembly, so cladding can be attached directly to the wall using standard rain-screen detailing, or not, depending on local climate conditions.

Deep Stud Walls with Service Wall. This wall assembly is a variation on the double wall. It consists of a deeper stud cavity created using either deep studs (2x8, 2x10, 2x12) or engineered wood I-joists with the air barrier installed on the inside face of the deep studs. An additional 2x4 service wall on the interior allows for electrical, plumbing, and HVAC services without penetrating the interior air barrier. These wall types may need to be engineered. High effective R-values of the assembly are achieved by filling the cavity with either batt insulation, blown-in fibrous insulation, or spray foam insulation. There is no exterior insulation installed in this assembly, so cladding can be attached directly to the wall using standard detailing.

A brief overview is given of several alternative wall assemblies that could potentially be used to achieve the R-22 thermal performance target, but are not covered within the guide. These include:

- Structurally Insulated Panels (SIPs)
- Interior Insulated Framed Wall
- Continuous Strapping
- Insulated Concrete Forms
- Insulated Concrete Forms (Below Grade)
- Interior Rigid Insulated and Batts (Below Grade)

Canadian Home Builders' Association

Technical Research Committee News

Canada-Wide Listing of Energy Efficiency Incentive And Rebate Programs

There are a variety of incentive programs designed to encourage energy conservation. The trouble is knowing how to find the right program for the right location, building type or energy-efficiency upgrade.

To simplify the search, NAIMA Canada, an association for manufacturers of fibreglass, rock wool, and slag wool insulation (mineral fibre insulation), has enhanced its website to include an easy-to-use source for information on energy-saving incentives and rebates across Canada.

After answering basic questions about their building type, province/territory, and utility company, users are presented with a list of relevant programs and their offerings. Many of the programs can be utilized for other energy-saving initiatives, which can be done at the same time as re-insulating.

The association plans to update the website regularly to provide current information from across Canada.

www.naimacanada.ca and look under the incentives & rebates tab.

Updating the Canadian Centre for Housing Technologies

The Canadian Centre for Housing Technologies (CCHT) is a unique research facility at the National Research Council's campus in Ottawa. The centre consists of two identical side-by-side, fully instrumented houses built to the R-2000 standard in 1998.

The CCHT was designed to provide a venue to help the development of new technologies and their acceptance in the marketplace. Manufacturers and innovators can test their innovative technologies in a fully instrumented house with simulated occupancy. The detailed monitoring can be compared to an identical house under identical conditions without the innovation before full field trials in occupied houses. Over the years more than 40 projects have been undertaken at CCHT, most involving innovative technologies.

A major capacity and capability upgrade has been announced recently. The upgrades will allow the facility to update and revamp the heating, ventilating, and air conditioning (HVAC) equipment, renewable energy and control testing systems, as well as the intelligent building and smart grid integration technologies. These systems will keep the centre a leading edge facility that will allow the testing of renewable energy systems such as wind and solar and how they can be seamlessly integrated into the existing electrical grid using intelligent load management strategies.

The upgrades will also allow the centre to expand its focus from only testing and assessing residential housing construction technologies to include other construction markets.

CHBA Launches Net-Zero Ready Initiative

A net-zero energy home is one that is designed and built to produce as much energy as it consumes on an annual basis.

The discussion about the fine points defining a net-zero home sometimes sounds like a theological debate about the number of angels that can dance on the head of a pin.

Issues that get caught up in the discussion include how the energy modelling is to be done, what the assumptions for occupant interaction with the house are – how many people there are in the house, how they use what kind of appliances and what temperatures they maintain. Then there are the considerations of how energy is generated on-site, what is to be considered, and how it's stored.

There is much discussion about as-operated conditions. Plug loads (lights and appliances) and occupant loads in very energy efficient homes can account for ½ to ⅔ of total energy use.

Although net-zero designs may have a number of elements that are common with all such houses, they also need special consideration of details because of the site-specific features. Most of these are climate related, but the characteristics of the site must also be considered. Are there any trees, mountains, cliffs, or other obstructions that may affect the solar access to the house? What is the latitude of the site (which will affect the number of potential hours of sunlight)? What is solar potential (cloud cover) at the site?

NRCan currently has a R-2000 Net-Zero Energy pilot project underway. It aims to recognize Canadian builders and homes reaching net-zero energy performance, with the goal of leading to formal integration of this recognition into its national standards.

Houses under NRCan's pilot will be rated using the new EnerGuide (ERS) scale and will strive towards 0 gigajoules (as opposed to the current EnerGuide scale rating of 100). The next generation ERS was designed specifically to handle net-zero energy homes; this pilot is a good opportunity to test it out. In addition, the project focuses on currently available off-the-shelf technology. This should assist the advancement of the commoditization of net-zero energy homes in Canada.

Because the tools for the new ERS calculation process are not finalized, the pilot relies on the current version of HOT2000 (v10.51) with some supplemental spreadsheets to take into account adjustments to default assumptions and renewable energy calculations that are not yet taken into account in HOT2000.

CHBA's Net-Zero Energy Labelling Program

CHBA's Net-Zero Energy Council is about to launch a new Canadian voluntary labelling initiative that clearly defines net-zero energy and net-zero energy ready homes for the general consumer. This will build on the R2000 standard and the R2000 net-zero energy pilot program.

The intent of the net-zero Energy (NZE) labelling program is to distinguish and recognize NZE homes and builders, to help with marketing and communications initiatives to develop the NZE brand, build awareness, recognition and cachet of "net-zero energy" homes and stimulate market demand. There will also be educational initiatives to bridge the knowledge gap for early adopters and accelerate builder capacity to capitalize on NZE.

The labelling program will actively pursue the refinement of a two-tier technical standard: net-zero energy (NZE) and net-zero energy Rready (NZEr).

The objective is to develop a program that has technical rigor and simplified administration. Rather than creating something new, it will build on the current R2000 standard and procedures, be accessible to all homebuilders and can include custom homes, renovations, large volume home production, as well as low-rise multifamily.

The yardstick will not be net-zero as operated, but rather will rely on default assumptions for occupant behaviour and plug loads. Energy produced that will be considered will be generated on-site, and renewable, and will include all forms, both passive and thermal, including acknowledgment of gas and electrical base loads.

The houses will have to meet the R2000 standard. This includes mandatory criteria for building envelopes that are significantly better than code minimum. Air conditioning will also be accounted for. The bottom line being that the house will achieve 0 energy use on an annual basis. The net-zero energy ready label will identify a NZE home that meets all criteria except that the renewable energy component has not yet been installed.

The Net-Zero Council recognizes that net-zero today is not the same as net-zero will be five years from now, because new technologies will be developed and refined, and the nature and efficiency of renewable energy technologies is changing fast.

The NZE labelling program will require CHBA membership, and will require R2000 builder training supplemented with a supplementary NZE Builder Training. Once a builder has completed their first labelled NZE/NZEr home, the builder will earn the designation of "CHBA NZEr/NZE Qualified Builder". To maintain the designation, they must participate in on-going NZE education and build at least one NZEr home every 3 years.

Integrating Renewables and Energy Efficiency in a Net-Zero Energy Residential Subdivision

Housing accounts for 17% of Canada's energy use and 15% of greenhouse gas emissions. Growth in the housing stock has contributed to a net 14% increase in household energy use since 1990. The energy consumption and greenhouse gas emissions from this sector will continue to grow unless the industry moves to build homes that are substantially more efficient. Net-Zero Energy Housing (NZEH) provides a means to accomplish these reductions.

The Canadian housing industry is large, but highly fractured with thousands of homebuilders. Individual builders have limited capacity to pool resources and share the risk associated with research and development. As a result most homebuilders rely on prescriptive packages from labelling programs such as Built-Green, R-2000 and Energy Star, and on the building code when designing the energy performance components of their homes.

A small but growing fraction of homebuilders are now building near- and net-zero energy (NZE) housing levels. The NZE home is one that employs enhanced energy efficiency design strategies to reduce energy needs, while supplementing with renewable energy technologies. The net result is that the house produces as much energy as it consumes on an annual basis.

Builders want to know which technologies will have the highest impact in reducing the first cost of NZE homes, and how best to integrate them. This will build the pathways required for NZE homes and communities to become more commonplace.

An NRCan funded project (with a two million dollar contribution) aims to demonstrate the feasibility of building net-zero energy housing (NZEH) communities in Ontario, Quebec, Nova Scotia, and Alberta. The lead proponent for this project is Owens Corning Canada. They have brought on the Canadian Solar Industries, Jeld-Wen Canada, Mitsubishi Electrical Services Canada, and Rheem Ltd. as project partners. Unlike earlier demonstration projects, which opened the door to explore new technologies, only leading edge, but readily available products, from each of these partners are to be used in the project.

Many current NZE homes are custom-built projects. They often use elaborate designs and expensive technologies and inputs that differ from the affordability pressures that production builders face. The five production builders that have been recruited are Mattamy Calgary Ltd., Reid's Heritage Homes, Minto Communities, Construction Voyer Inc. and Provident Development Inc. Each will build five net-zero energy homes.

By focusing on affordability and market acceptance, the project's production builders are taking on the challenges associated with mainstreaming NZE practices. The project aims to address the challenges of building to NZEH performance levels specific to large volume production housing and to act as a platform for the broader adoption of NZEH across Canada. In addition, this project is to assess and resolve challenges in relation to site planning, construction, equipment, grid connections, cost, trade capability, warranty, reliability, sales, marketing, and homebuyer information/education.

Owens Corning has brought on buildABILITY Corporation to coordinate a team of experts in building technology, building science, solar technology, and energy efficiency, each with experience mentoring production builders to adopt voluntary energy efficiency/renewable energy measures including NZEH.

The outcome of this Projecteis guidelines for building NZEH communities in a production setting differentiated across five communities in four provinces, reflecting differences in building regulations and local site builder and homebuyer preferences. Project insights are to be disseminated to the industry to promote and facilitate the construction of other NZEH communities.

To date, only one house has been completed in Guelph by Reid's Heritage Homes, which had its official opening in early September 2015. Minto has begun construction on their project in their development in Kanata (suburban Ottawa). Construction Voyer broke ground on their six-unit condo project in Laval, Quebec in June.

The Cost of Inadequate Design and Execution

Dara Bowser

Consumers who purchase new homes assume that the regulatory and warranty agencies involved will prevent sub-standard systems from being installed. They also expect that, when it becomes known that a certain system is found to be sub-standard, something will be done about it.

A consumer group in Ontario has called for an inquiry to investigate the failure to enforce the Ontario Building Code by key players in the construction sector.

The issue that generated the call for an inquiry is focused on improperly designed and installed mechanical systems in new homes. It arose as a result of problems with small diameter high velocity heating systems. The substandard systems resulted in inadequate heating in the winter and poor summer air conditioning performance.

It also affected some consumers whose home value was significantly reduced because of the problem, with extra costs for remediation of the system after the fact. Failure to disclose the fact that the heating system is defective may also make a homeowner liable for damages when the house is sold. In some cases, the problem was only properly assessed after expiry of the warranty claim date so that the home warranty program would not accept the claims.

While this problem can pose significant and costly problems for new home purchasers, it has also been and will continue to be costly for homebuilders and HVAC installers who unwittingly install deficient systems in new homes.

Small diameter high velocity heating systems are systems that can be designed to provide heating, cooling, filtration, ventilation, humidification and dehumidification. It is quite different from a conventional furnace – the main difference being that the supply duct work is all small diameter, flexible ducting (typically 2" diameter).

The small diameter ductwork is what attracts interest because it makes it easy to install the flex ducts inside existing framed walls with minimal remodelling in retrofit situations. In new construction, the smaller ductwork reduces the need for large duct bulkheads and dropped ceilings to accommodate conventional sheet metal ducts.

Instead of typical supply registers, they use "nozzles" that heat or cool rooms with a jet of air. Trunk ducts are also small, to maintain equal pressures and velocities throughout the system. They require multiple nozzles in each room.

However, the system operates at a higher static pressure (1.5" and up) to compensate for the smaller diameter ductwork, so the fans used to move the air have characteristics that differ significantly from conventional forced air heating systems. But even with the greater fan capacity, design and precision installation are still critical to ensure adequate airflow and to achieve required heat delivery.

Commissioning of small diameter high velocity heating systems, to be sure the system is operating at maximum capacity, is different than with conventional forced warm air systems. Additional testing is required to verify correct airflows because the higher velocity at the fan discharge requires a different protocol to get proper pressure measurements.

The Ontario Building Code does not contain mandatory performance testing requirements for the air-handling equipment used for these small diameter systems, and other hot-water air-handler units, but it does contain mandatory performance standards for many other HVAC products such as furnace, heat pumps and heat recovery ventilators.

The Heating Refrigeration and Air Conditioning Institute of Canada (HRAI) qualifies and trains HVAC designers to prepare designs that are expected to comply with the Ontario Building Code. Unfortunately, the HRAI Residential Air System Design Manual does not contain guidelines for the design of small diameter heating and ventilation systems.

In a number of cases it was found that the small diameter ducting systems were not properly designed or installed, with the result that they were not able to properly heat the homes. Performance shortfalls of 20% to 50% of the required heating capacity are often measured when installations are investigated.

In one case, the third-party engineer engaged by the warranty program recommended complete replacement of the heating equipment as well as significant modifications to the ductwork system, and added that he believed that a shortfall in heating output capacity is common to all such units installed in the development.

In another case, the original purchaser of the new home subsequently sold the home but was sued successfully in small claims court by the second purchaser of the home on the basis that the HVAC system was substandard. The original purchaser of the home was held responsible for the failure of the Ontario building and regulatory system to provide a home that complied with the OBC.

In some cases, winter conditions recorded in the homes failed to meet the requirements of the municipality's property standards by-law. Thus, although the owners purchased homes that were approved by the municipal building code enforcement department, they are not able to rent their homes because to do so would be a violation of the same municipality's property standards by-law.

If the systems are unable to provide the required performance, by definition they fail to comply with the Ontario Building Code with respect to design as well as performance.

Although representations were made to the Ontario agencies that could take action on this, little seems to have been done. In a number of instances of non-compliance that were identified, each of the municipalities concerned had a policy of enforcing all of the residential HVAC requirements of the Ontario Building Code.

Aside from the obligation of municipalities to enforce the code, other agencies and organisations have obligations to implement code requirements, including the new home warranty program, and the professional organizations (engineers and architects) who qualify and discipline the professionals who prepare designs that are expected to comply with the code. And the (Ontario) Building Code Commission is expected to rule on disputes between owners and builders and municipal building officials concerning matters of code interpretation and whether or not an order by the chief building official of a municipality has been properly issued.

In the case of the faulty mechanical systems, despite a number of formal complaints, investigations, hearings, and rulings, where problems were identified, there was no remediation, and home purchasers were left to fend for themselves – the cost of remediation in some cases approached $100,000.

The Ontario Building Code Act makes it clear that municipalities are responsible for the enforcement of the Ontario Building Code. At present, enforcement of the residential mechanical requirements in the code is interpreted as being optional. It shows how Ontario's system of new home regulation, quality assurance and mandatory warranty may not protect new home purchasers even when significant breaches of the province's Building Code occur.

While this is an Ontario problem, it has national implications and leads to some bigger questions about whether or not our current model of municipal regulation, practitioner qualification and warranty are the right ones, and what needs to be done to correct this. ☼

You Asked Us:
About Rigid Foam Board Insulation And Vapour Barriers

Isn't the purpose of the inside vapour barrier to prevent moisture from penetrating the insulation and condensing somewhere in the middle of it? If that's the case, wouldn't a layer of continuous extruded polystyrene insulation (e.g. Styrofoam or CodeBord) on the outside of an exterior wall be a vapour barrier? Since it's outside of the fibre batts in the studs, could it result in moisture condensing somewhere in the fibreglass, or on the inside surface of the extruded polystyrene?

MS, Vancouver

You raise a frequently asked question, and it reflects a common misconception.

It is important to understand that vapour drive accounts for maybe 2% of the moisture movement through a wall assembly. Moisture moves by vapour diffusion – the movement of water molecules in the air through permeable materials, and by air movement. About 98% of moisture movement through the wall happens as a result of air leakage. That is why air tightness is important.

In a wall assembly, condensation may take place on cold surfaces if there is air leaking outward from the interior, and to a much lesser extent, by diffusion if the interior materials are vapour open.

The specific amount of moisture movement depends on a number of factors, including absolute moisture content of air on either side of the assembly, the temperature difference between inside and outside, the pressure difference across the wall, the airtightness of the assembly and the vapour permeability.

A vapour impermeable material that remains above the dew point will never see condensation – you need a cold surface for that to happen. When you take a cold container out of the fridge and see sweating on the outside of that container it tells you that the surface is below the dew point of the air at that point. Think of those insulated sleeves for cold drinks we use in summer – they keep the beer or pop can cold, but the outside of the sleeve makes it comfortable to hold in the hand. The sleeve is an insulation layer that works exactly like the foam board on the outside of a wall.

Extruded polystyrene insulation on the outside of a wall provides an insulation layer – the outside face will be close to outdoor ambient temperature, and the inside face will be warmer because of the insulation value of the foam board. The interior face temperature will depend on how thick that foam board is and also on how much insulation there is on the interior.

The interior face of the extruded polystyrene insulation is a vapour impermeable surface, so it could be a condensing surface - however it will generally remain above the dew-point temperature of moisture (depending on how thick it is, the climate zone, and the conditions in the building). In most of southern Canada (zones 4, 5, 6) there is little likelihood of condensation issues with 1½ or 2" of extruded polystyrene on the outside of a wall with R-20 inside, and could safely be considered to provide the required vapour diffusion resistance required. Drywall painted with a vapour barrier paint on the interior will provide adequate vapour diffusion for most indoor conditions.

Environments with long term high humidity (50% or more) would require careful review. However, these are generally special locations such as indoor pools or spas.

Analysis, testing and field monitoring have shown quite clearly that continuous extruded polystyrene will not lead to condensation inside the assembly. ☼

US EPA Plans To Remove Reflective Insulation from Energy Star Program

The US Energy Star program (unlike in Canada) includes insulation products in their product certification. Only insulation tested by US Environmental Protection Agency (EPA)-recognized independent third-party testing agencies are eligible. The performance of insulation is also highly dependent on the quality of the installation, so Energy Star also requires manufacturer partners to include instructions that clearly explain how to install their products to ensure maximum performance.

In September 2011, the EPA finalized new participation requirements for their "Seal and Insulate with Energy Star®" Program for insulation products. Since the implementation of these requirements, several key issues have emerged regarding reflective insulation products that have prompted the EPA to reconsider the applicability of these products within the scope of 'Seal and Insulate with Energy Star.'.

To date, no reflective insulation manufacturer has met the certification requirements for the 'Seal And Insulate With Energy Star' program for any of their products.

Manufacturers have had a difficult time showing how reflective insulation products can meet building codes as a stand-alone product or integrated into a whole wall, ceiling, roof deck, or floor system insulation strategy.

Manufacturers claim their products can be used in applications that EPA does not certify. Those uncertified applications may lead consumers to be misled to think the products were certified though the EPA-recognized certification body for those non-certified applications.

As a result of these concerns, on April 6, 2015, the EPA issued a letter indicating they are considering the removal of reflective insulation from the 'Seal and Insulate with Energy Star' Program and adding it to the list of excluded products. ☼

Insulation Products

Increasing insulation requirements, especially with building codes making *effective* insulation values the requirement, is leading to innovations among insulation manufacturers.

The increased movement to ever higher performance building envelopes means that construction assemblies are beginning to look much different from that seen in the past. The requirement to use effective R-values means that unlike past practice of relying only on the nominal R-value of the insulation being used for analysis and code compliance, all material layers must be taken into account when calculating the R-value. The days of the standard single stud wall with insulation between the studs, a single layer of exterior structural sheathing, and interior finish are numbered.

New construction assemblies are beginning to be used with varying combinations of materials, including continuous layers of insulation to reduce thermal bridging. Product manufacturers are stepping up with new products, or modifying existing materials. Some may be more practical to use than others. Some may be easier to work with than others.

All will require rethinking construction processes and require review of construction details, since the installation of the materials themselves may be easy.

At the same time, as we increase the insulation, we need to be sensitive to the properties of the materials in the assemblies, as that will impact the performance and durability of the assembly. As we increase the insulation levels, we reduce the heat loss from the building, with the result that the materials on the exterior remain much colder. Moisture accumulation and drying potential of the materials also changes. This is where the concern about vapour permeability and double vapour barriers becomes a concern.

In addition, the interface details between elements also requires more consideration. How does the new combination of materials deal with window and door openings? How easy is it to deal with ducts or other service penetrations through the wall? Are there any limitations on exterior cladding installation?

Vancouver, although it has the mildest climate in the country, introduced very aggressive prescriptive requirements (R-22). Although it is a mild climate, it also is a wet climate. Consideration of moisture management in construction

has already been raised. Vancouver builders and designers are starting to investigate a variety of construction options – from thick stud walls, double stud walls, to stud walls with continuous exterior insulation.

New construction materials are showing up on the market, as manufacturers try to take advantage of new code requirements, as they jockey for market share. We present a sampling of new materials that we've come across recently.

Tyvek ThermaWrap™

Dupont developed Tyvek a number of years ago. They found that it had a number of useful properties for use in construction – it is a synthetic, water repellent and lightweight membrane that is strong, airtight and vapour permeable. In many places, Tyvek (and other similar materials from competitors) has replaced the more traditional asphalt papers or felts that were used as weather barriers on the exterior of buildings. With proper installation and detailing, it can be installed to provide not only the weather barrier function, but also to provide an air barrier.

Dupont has now developed a new product they are calling Tyvek ThermaWrap R5.0. This combines an insulating fibrous blanket with a Tyvek sheet. Think of wrapping the house in a 1½" thick fibre batt blanket. The batt provides an R-5 insulation, with the adhered Tyvek membrane being the air and weather barrier.

The high vapour permeability of the Tyvek allows the assembly to 'breathe' so that any moisture that may penetrate into the wall cavity it can escape back to the exterior, rather than being trapped in the wall.

The manufacturer's information points out is can be installed using similar procedures as Tyvek. The four-foot wide rolls include 6" uninsulated flaps that allowing for all joints to be installed shingle fashion.

A major drawback to this product is that installation of exterior claddings that need solid backing, such as stucco, lap siding, or stone veneers, requires extra components and installation detailing. To deal with this issue and to maintain a continuous insulation layer across the wall, Dupont has developed an insulated batten. It is an insulated strap – 3" wide, four feet long, made from a ¾" plywood and a ¾" strip of extruded polystyrene insulation. These are meant to be installed directly on the sheathing. The ThermaWrap blanket is then installed over the battens – the batt being compressed as it is fastened.

The compressed material could possibly be an issue for siding support and providing a continuous, smooth surface. The other concern should be the detailing for penetrations in the wall – especially windows and doors.

Proloft®

Proloft® is a new 'space age' insulation made from an aerogel material. It is a semi-rigid batt that has the highest R-value per inch (R-10) compared to conventional insulation products in the market today. It also is the most expensive product on the market – so the distributors are wisely not targeting this product as an insulation by itself, but rather as a complement to other products, to help reduce the thermal bridging across framing.

Proloft is being sold in 10 mm (3/8") thick strips that can be adhered to the framing, thus creating a thermal break. The 10 mm thickness provides R-4 insulation. Although it is a soft and flexible material, it has excellent spring back. It recovers its thermal performance even after compression events as high as 50 psi. It would be especially valuable with steel framing.

It can be custom-cut as required using conventional textile cutting tools including scissors, electric scissors, and razor knives. However, the material can be dusty, so gloves, safety glasses, and dust masks should be worn when handling the material.

Proloft has a Class A fire rating allowing for its use in the construction of fireproof framing assemblies. It is a hydrophobic matter that repels liquid water but is vapour open, allowing vapour to pass through the material. It is a good material for use in areas subject to high moisture loads and mould prone areas. It is a reusable non-toxic landfill disposable material with no respirable fiber content.

Advanced Insolutions Inc.
www.advancedinsolutions.com
1-855-847-8555

Extruded Polystyrene Insulation (EPS)

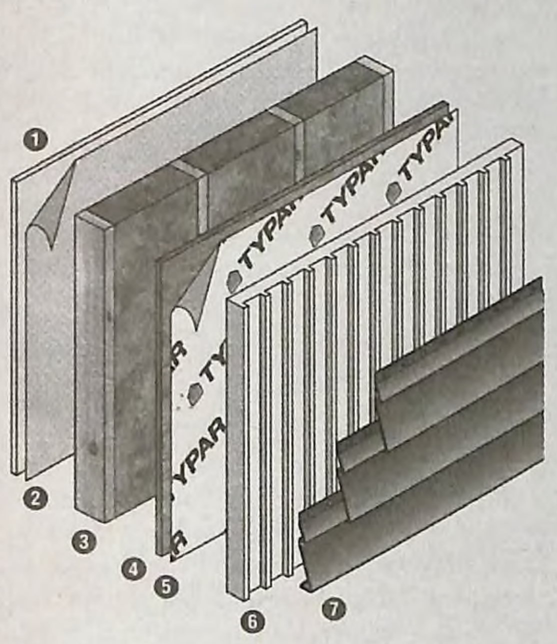
Extruded polystyrene insulation (also referred to as bead board) is a fairly generic product. It is a relatively inexpensive product, easy to cut and shape – it is the same material that is used for packaging and food containers.

As an insulation material, with an R-value of R-4 per inch thickness, it has a lower R-value than extruded polystyrene, but higher than fibrous materials. Unlike some cellular materials, EPS is thermally stable – the R-value does not change over time.

Because EPS is a generic material, the basic material is less expensive than extruded polystyrene. It also has a higher vapour permeability than extruded polystyrene. EPS could be considered as being semi-permeable.

A number of manufacturers market the product as insulation. Because it is easy to work with, custom sizes and shapes can be developed quickly. We are seeing some preparing shaped products for specific applications.

EPS is recyclable and ozone layer friendly, as it does not contain any CFCs or HCFCs.



Interior to Exterior

1. Gypsum wallboard
2. Polyethylene
3. 2x4 or 2x6 stud wall with insulation
4. Sheathing (plywood or OSB)
5. Sheathing membrane (eg Typar®)
6. Vertibreak® Rainscreen Insulation (Z4, Z5 or ZV)
7. Cladding

Vertibreak Rainscreen Insulation

Powerhouse Products Inc. is a Vancouver area distributor of building materials that distributes a number of rain screen construction products. To address the move to continuous insulation across the face of the exterior structure, they developed an EPS rain screen panel.

The **Vertibreak** rainscreen insulation panel provides z rainscreen and insulation in a single panel. It essentially is an EPS panel that has been grooved with vertical channels to provide the rainscreen cavity. The channel spacing provides an 80% open surface which conforms to code requirements for rain-screen.

The panels come in several thicknesses from 1-7/16" to 2-7/16" thick, depending on insulation requirements. The panels are sized so that minimum code requirements for climate zones 4 and 5 could be satisfied with 2x4 framing plus the Vertibreak panel. A thicker panel is designed to meet Vancouver city's more stringent R-22 effective (RSI 3,85) requirements.

A variety of cladding materials can be applied without adding furring strips. Lightweight claddings (up to 10 lb/sf) can simply be nailed through the panel to the structure. If the cladding is heavy (such as natural stone tile on a cement backing) and additional support is needed, furring strips can be friction fit into the panel

grooves, and then fastened to the structure.

If additional continuous insulation is installed behind the panel, then furring strips would be needed.

Www.powerhousebuildingsolutions.com
Toll-Free: 1-877-337-2802

Halo

A graphite-enhanced variation on standard EPS was developed by BASF, and is marketed under the name of Neopor. The material has the texture of conventional EPS, but the graphite gives it a charcoal grey colour and increases the R-value to about 4.5/inch.

A new line of branded Neoper EPS products has recently been launched in Western Canada. They are being sold for interior, exterior, and underground applications under the Halo brand. When installed across the face of the framing, either inside or outside, it reduces heat loss due to thermal bridging.

The sheets are 4'x8' and up to 2" thick. The large sheets reduce the number of joints that may need to be sealed.

Halo Exterra™ is a Neopor board, laminated with a clear perforated polypropylene sheet that is specifically designed for exterior above-grade walls.

In thicknesses up to 1-5/8" it has a permeance greater than 60 ng/Pa-s-m^2 so it can be considered to be permeable. When the joints are taped, it will act as an air barrier, as well as weather barrier, eliminating the need for a separate house wrap.

The 2" thick panel has a lower permeability, qualifying it as a vapour barrier, so the wall assembly must be detailed taking this into account.

Halo Interra™ is a Neopor board for interior use. A reflective polypropylene laminate is installed on both sides. With a permeance of 1.7 ng/Pa-s-m^2 it thus provides the required vapour barrier. It the interior face is strapped with ¾" strapping, the reflective face can add about R-2.8 to the effective R-value.

This can be used for above-slab floors, radiant floors and the interior surfaces of walls & ceilings.

Halo Subterra™ is a for use below-grade – under floor slabs or to insulate below grade foundation walls. The board is laminated on both sides with a woven polypropylene laminate membrane.

http://buildwithhalo.com
tel: 855-350-4256

You Asked Us About:
Passive House and R-2000

Was Passive House from Austria really originated off of R-2000? I believe that Passive House is a much higher standard than R-2000 though.

RJ, Vancouver

Yes, a major influence on the passive house movement was Canadian. Passive house folks recognize the importance of the Saskatchewan Conservation house, built in 1976, which was the underpinning of super insulated homes, and which led directly to the R-2000 program. One of the key people behind the Saskatchewan Conservation house was Harold Orr, to whom the passive house folks gave a pioneer award this year at their annual conference in Germany.

The R-2000 program was probably the first comprehensive energy efficient home program in the world, and was used as a template for many other energy efficiency programs around the world.

At the outset, the R-2000 energy targets were 50% better than good conventional construction. Over the years, as energy standards and practices improved, the difference between code and R-2000 decreased. However, the standard has been updated several times over the years - the latest sets the energy target at a minimum of 50% better than the latest applicable energy code requirements – so that as codes are upgraded, that differential will always be there.

continued next page...

Energy Answers

Rob Dumont: In Memoriam

It's with great sadness I am writing this piece, announcing the passing of Dr. Robert Dumont on May 29, 2015.

I first met Rob when we were both young university students. We both landed a summer job in Kitimat at the Alcan aluminium smelter (where, as Rob would later say, they froze electricity). Although I had grown up in Kitimat, it turned out we had mutual acquaintances from high school and the church, and as happens in life, our paths crossed a few years later at the Solar Energy Society conferences, and then with R-2000 activities.

After graduation from UBC as a mechanical engineer, Rob volunteered with CUSO in Kenya where he taught at the Kenya Polytechnic University in Nairobi. Following his overseas travels, he moved to Saskatoon where he received his Masters and PhD from the University of Saskatoon and settled permanently working for the National Research Council and Saskatchewan Research Councils. His focus was building physics and energy efficiency.

He was an active player in the group that designed and built the Saskatchewan Conservation House in 1977 that took the world by storm. It was one of the first demonstration houses that showed how very high performance homes could be built largely with technologies available at the time. It was the technical underpinning of the R-2000 Standard and showed the world how, by careful design and execution, energy efficient, high performance houses could be built. It was a template that resonates to this day.

His strong sense of integrity and responsibility meant he not only talked the talk, but also lived it. Soon after his marriage, he built his family home as one of the most highly insulated, energy efficient home in the world at the time – long before anyone had heard of net-zero energy homes. In his writings he often included references to features in his house as an example of what he was referring to.

A man of few wants, he loved the simple things in life and believed in the underdog. He worked hard to improve housing conditions, whether it was in northern Saskatchewan, Africa, or elsewhere. He had a deep commitment to social justice and the environment.

Rob made many contributions to the cause of a more sustainable environment for future generations. His professional work on energy efficiency and indoor air quality gained him worldwide recognition. He was a contributor at many conferences, as well as contributor and member on many technical bodies, and received recognition and awards from many organizations in Canada and abroad. He left a big mark. He'll rest in peace now, but won't be forgotten.

Rob is survived by his wife Philippine Schaan and daughter Marie, as well as a large extended family of siblings, nieces and nephews. ☼

When an equivalent comparison is done, the R-2000 standard actually is close in terms of performance to the passive house standard. The Europeans obviously tweaked it to their way of looking at things and conditions. One of the problems with the passive house approach is that they are using some of their own metrics - so that they are not really comparing apples to apples.

One significant point about R-2000 is that from day one it focused on the builders who need to be able to execute the standard. Thus capacity building (builder training, energy advisors, inspectors, etc.) was a part of the activity all along. This is unlike the European approach that relies much more on an academic process and on consultants – so it is not as accessible for builders.

This billboard was spotted in the Polish countryside, advertising Canadian-style wood frame construction. The billboard says "1,950 Zloty per square meter for a completed house, by Canadian Homes by Szostak" (current conversion is approximately Cdn $1 = 2.80 Zloty)

Seen In The Polish Countryside

Although Poland has a tradition of wood carpentry and some wood construction, most housing construction is masonry – less than 10% of housing starts are built using wood frame construction. However, it is interesting to note that any contemporary wood frame construction is referred to as 'Canadian'.

Canadian-style wood frame construction is gaining popularity, and it is estimated that more than 80% of wood frame construction essentially conforms to Canadian wood frame standards.

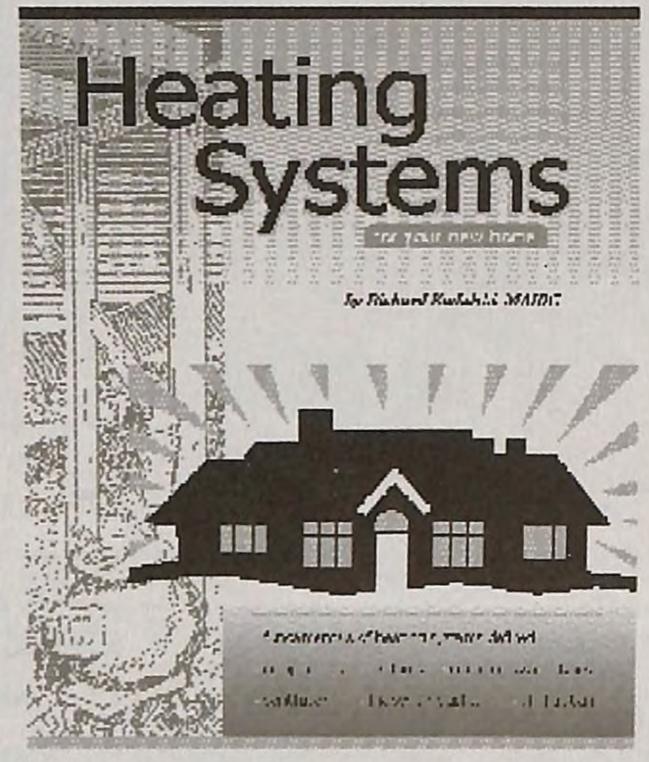
Real estate listings are full of references to either 'traditional' or 'Canadian' construction for wood frame construction, whether it really is Canadian-style platform framing, or using other European panelised approaches.

For a variety of historical reasons, Canada has had a very positive image in the country.

Following the end of the Cold War in the late 1980s, when central Europe was shifting its focus and rebuilding its economy, there was interest in forging closer ties with Canada. A number of Canadian and US design and construction publications were translated. I recall in the early 1990s seeing a CMHC house construction poster, translated into Polish, posted in a prominent location at a building supply outlet.

Since then, a vibrant publishing environment has spawned a number of publications that heavily focus on wood frame construction details and practices. These have been instrumental in providing guidance on Canadian style construction practices and detailing.

In the early 1990s some tentative overtures were made to explore Canadian housing technology exports to Poland, but there was little follow up, and the opportunity for Canadian exporters was lost. When Poland joined the European Union, focus shifted to EU norms and standards, although Canadian technology is still being exploited, and builders still use the 'Canadian' moniker.



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